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EXPERIMENTAL MUSICAL INSTRUMENTS

FOR THE DESIGN, CONSTRUCTION AND ENJOYMENT OF NEW SOUND SOURCES

The leading articles in this issue of **Experimental Musical Instruments** feature the work of two very independent-minded builders, Ivor Darreg and Daniel Schmidt. Ivor Darreg has let it be known that he had his first piano lesson over sixty years ago, and that he concluded not long after that it was time to move on. Many and varied are the monuments to his intellectual adventurousness since then; among them is the Megalyra family of instruments he describes beginning on page 10. Daniel Schmidt is a composer and a builder of new gamelan instruments, with designs that are rooted in but independent of the traditional Indonesian instrument types. The article on his work begins at right on this page.

Response to the tapes question raised in the last issue (should EMI produce cassette tapes featuring the instruments covered in the articles?) has been considerably more positive than previously. This response will help to get some wheels turning and bring the idea closer to reality. We are still, of course, interested in hearing opinions and suggestions on the subject.

IN THIS ISSUE

DANIEL SCHMIDT'S AMERICAN GAMELAN INSTRUMENTS

In recent years a number of American composers and instrument builders have developed an interest in Gamelan music. A Gamelan is an Indonesian orchestra composed primarily of metalophones (metal sounding bar instruments) and gongs. These are usually complemented by a smaller number of instruments of other types, including bowed and plucked string instruments, drums, a bamboo flute and a vocalist. A gamelan is a complete set of such instruments, and the word refers to the instruments themselves, not the players or the music. The music itself has, to Western ears, an exotic, floating quality which many find utterly enchanting; Debussy is known to have been profoundly moved and lastingly influenced by his one encounter with it. Within its own culture it is afforded the greatest respect as the culmination of a long and highly-refined tradition, replete with painstakingly-taught performance practice and theory, and a rich surrounding culture.

The relationship of the American musicians to Indonesian models varies considerably. Many have considered it important to remain as true as possible to the Indonesian traditions in composition, instrument building and less tangible aspects of the music culture. But an increasing number of people on this side of the Pacific have taken the position that respect for the tradition does not demand literal emulation. With this attitude taking hold, new musical styles have begun to arise out of the U.S.-Pacific confluence. The love of the Indonesian music, its methods, structures, timbres, moods and surrounding culture, has been leading to increasingly independent creative work here. Some of the new music resembles traditional gamelan music closely, and some it is very different.

In the mid seventies there was only a handful of people exploring a non-traditional approach to

(continued on page 4)

LETTERS

Thank you for having begun my subscription so promptly; as a matter of fact, the sampler issue which you sent me was vol. I #5, the same as my first subscription issue. I've been criculating the sampler issue amongst my Swiss friends who have a working knowledge of English and an expanded curiosity of instrumental music potentials. In my opinion, **EMI** could be considered as an excellent trans-Atlantic liason for Europeans interested in relating their findings concerning "the design, construction and enjoyment of new sound sources."

With respect to European publications, I've been a regular subscriber to a French quarterly called **Cahiers de L'animation Musicale**, published by the "Centre National D'Animation Musicale" (CENAM, 51 rue Vivienne, 75002 Paris, France). Each issue centers on one music related activity; the range of topics covered since the quarterly's first publication in 1976 reflect CENAM's efforts to remain as open as possible to the musical past, present and future of France. (Examples of some of the themes covered in past issues: "The Sonar Galerie" Dec. '76, "Street Musicians" Dec. '77, "Intercity Music Schools" Nov. '79, "Songs and Singing" Jan. '83, "Teaching Jazz" Sept. '84)... In addition to the above listed topics, there are three issues which might be of particular interest to fellow readers of EMI:

No.7 1978 "Inventer des Instruments" (helas, out of print)

No.26 1983 "La Facture Instrumental et Dossier Musicoliers"

No.27 1983 "L'adresse des Facteurs"

No.28 1983 "Electroacoustique et facture instrumental"

I'll gladly answer -- to the best of my ability -- any questions concerning this publication unless, of course, those who are fluent enough in French might want to write directly to CENAM (see above address).

One final request on my behalf: I'm looking for a copy of **Music of the Whole Earth** by David Reck, published in 1977 by Charles Scribner's Sons. Any information concerning this book would be greatly appreciated.

Thank you for your attention and "bonne continuation" with EMI.

William Holden
Industrie 14, La Chaux-de-Fonds
Switzerland, C H 2300

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I would like to see more information published about musical instrument strings, both in form of a general article on the subject and also integrated into your articles on specific stringed instruments.

For example your article on P.J. Croset's Lyra said that he could not use conventional strings (vol. I #1, p.3) but failed to mention what strings he does use, where he gets them, or what tolerances are close enough. Similarly, the piece on Ellen Fullman's Long String Instrument was helpful to some degree but stopped short of providing precise information on what kind of wire she uses (piano wire? bailing wire?), where she gets it, what she has tried that doesn't work, etc. (vol 1 #2, pp.4-5).

Secondly, in your first issue you mentioned the possibility of offering cassette recordings of the instruments you write about. It seems to me that this is not just a good idea, but an integrally important facet of what you are doing and I look forward to hearing the instruments speak for themselves. Thank you for a wonderful and unique service.

Bill Minor

Editor's note: Bill wrote this letter around the time the last issue was at press. In that issue's editorial we raised again the question of making tapes (and have had considerably more response this time) and also the possibility of an article on string types. We are still interested in hearing from people who know enough on that subject to write a good article. Meanwhile, Ivor Darreg, in his article in this issue, provides some very useful information on strings in connection with his Megalyra family of instruments.

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Well, you already know I like the mag, so here I am voting early and often, as Pogo would say.

Regarding your editorial: yes, you should make tapes available; it would be great. However, I foresee possibilities for tremendous hassles in doing this. Distributing existing tapes might work; actual production - well, it depends on how much energy and experience you have.

For me, the mag's avoidance of electronically generated sounds represents a kind of integrity. I have some interest in this stuff, my friend is getting midi, etc., but synthesis and even sampling seem always to play catch-up, attempting to duplicate acoustically generated sounds and intonations, always with a musically unaffecting timbre.

The gentle boxed discourse on intonations (page 9; I assume it's yours) is a good answer to questions about technical information. Go ahead and slip in something about ratios.

Tom Baker

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Greetings from Down South

Got your new issue and you were wondering about your "scope" -- what should EMI cover? I had this problem several times [in publishing the **Xenharmonic Bulletin**] and Jonathan [Glasier] has it with **Interval**. John Chalmers who recently revived **Xenharmonikon** (please don't confuse with my **Xenharmonic Bulletins** which came first) evaded the question by making it a co-op journal where he

simply reproduced and bound together the contributions typed up by the various writers -- well, his scope was music theory mostly, with some scores.

One way out for EMI would be to declare a "gray area" -- subjects at the outer fringe or penumbra of your interests, which would sometimes get covered. An example would be loudspeaker boxes -- these are acoustic contraptions -- I'm not talking about speaker cones or mechanisms, but the air-space inside the box and the openings -- size and shape and resonance of the enclosure or lack of resonance. The Megalyra is profoundly changed by changing the boxes its speakers are in. Or the boxes on the equipment in somebody's living room the Megalyra recording is played through.

I can see another way to define the scope so far as which instruments get attention and which don't. Can Instrument X be made at home or not? Is instrument X available in fairly large numbers from factories? I think you already have those criteria in place -- this is my Sherlock-Holmes deduction. Am I right? I don't think you will choke up your pages with details of violin making for instance, because this although acoustic and small-scale handicraft, is slavish copying of a very old design which hasn't changed due to puristic conservatism. It's not experimental, so on the face of it it would be outside the focus of interest.

When it comes to electronic instruments, some of them are mass-production items that could not be built at home and in some case couldn't even be repaired or modified at home. On the other hand, there are one-of-a-kind highly individualistic electronic instruments that could never be manufactured in quantity because of the very design. After being scolded for 50 years for building such, because no manufacturer would want to make them, and various nasty people thinking it was a sin or breach of etiquette or something to make unique instruments instead of selling out to a mass-production factory which can only turn out identical-peas-in-a-pod, I must insist that "electronic" is not a synonym for "produced only in quantities of thousands of identical items".

The only way I can make this clear to anybody, is to put the sounds of homemade unique instruments and the sounds of commercially quality-produced instruments on the same cassette cheek-by-jowl. So I won't inflict any dilemmas upon you by asking you to consider something for EMI that might violate your scope. Your remarks about the Thereminvox in a previous issue show that you do understand.

Now I have a thorny semantic question that cannot be ignored anymore -- I have received tapes of instruments that do not exist. A computer program is not an instrument but I have recordings of them! This would be outside the scope of your magazine. The program is typed into the computer and the composition is typed in to be acted upon. Both are compositions in a sense. I mean that writing a computer program is not all that different from composing a prelude.

My taking cello lessons 55 years ago meant that the teacher programmed me. There are no frets on a cello fingerboard, but the cellist has them programmed into him.

I found that out when I tried to play something on the cello which I had composed on the 19-tone refretted guitar. Programming or software therefore has existed long long before computers were ever dreamt of.

To put it another way, there are certain sounds or effects which would be too expensive to realize by building an instrument, but they still can be heard by writing a computer program. Since this cannot be seen or felt, as you already pointed out in the current issue, that would be outside the field of your magazine. Other things are mechanically impossible.

Glad to see pictures of Stephen Smith's conduit marimba and other instruments. He visited me some time ago and saw mine before I was forced to move and store them.

Ivor Darreg.

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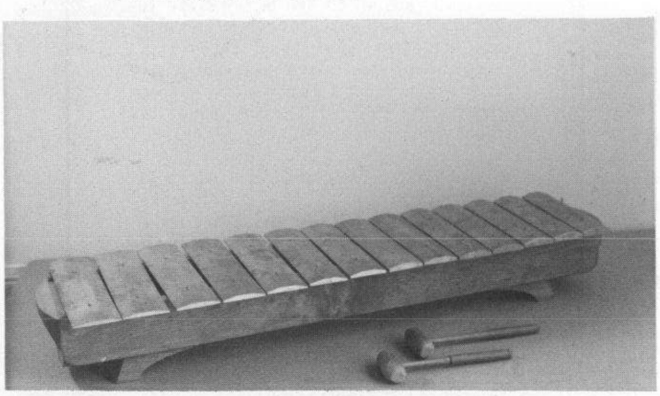
(continued from page 1)

gamelan music. They included Paul Dresher (now mostly working with interactive performance-oriented electronics), Jody Diamond (now director of the Bay Area New Gamelan and the Mills College Gamelan); composer Lou Harrison, working in conjunction with builder Bill Colvig; and Barbara Benary in New York, director of the Son of Lion gamelan (which was using instruments derived from found objects, designed by Dennis Murphy). Daniel Schmidt was among these people too, building and composing for gamelan-like instruments in non-Indonesian ways. The music was a bastard child then: the prevailing aesthetic in new music was still running in a post-serialist highbrow vein; ethnomusicologists meanwhile were primarily concerned with preserving existing traditions in unadulterated form; and non-traditional gamelan didn't get much respect. Things are a little different now, and that is a credit to the work and the imagination of the early new gamelan people mentioned above. The movement for new approaches to gamelan music has grown in size, gained some respectability, and established validity.

Daniel Schmidt has been building gamelan instruments since 1975. In that time he has earned a substantial reputation, and his instruments have spread far and wide: the gamelan used at North Texas State University and Sonoma State University are his, as well as those played by musicians of the Berkeley Gamelan and the Bay Area New Gamelan, to mention a few. His gamelan are traditional in this sense: they comprise complete sets of the metal instruments (strings, winds and drums are not included), with instruments corresponding to a Javanese gamelan in range, number, and, loosely speaking, type. Traditional gamelan music can be performed effectively on them. But in designing them Schmidt makes decisions based on his own ear, rather than on the dictates of tradition. The resulting instruments differ from Javanese and Balinese instruments in several respects. Most prominently, Schmidt makes the sounding bars and gongs of aluminum and brass, machined to shape, while builders in Indonesia use forged bronze.

Below: BRASS DEMUNG. At right: SARONS
Photos by Daniel Schmidt

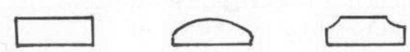


The cross section shape of Schmidt's bars and gongs are his own. And he makes more extensive use of tuned air resonators than is traditional.

Schmidt's approach to instrument building is disciplined and hard-working, tending to the cerebral. The instruments themselves show a high degree of understated craftsmanship. They are never showy -- visual effect is only a secondary concern -- but matters which affect the acoustic result receive detailed attention. Tuning, both for the relationships between fundamental pitches of different bars and for timbre within a single bar, is perhaps Schmidt's primary interest. The resulting instruments are quietly handsome to look at, and in sound, virtually flawless. Descriptions of the basic instrument types follow.

TROUGH-RESONATED INSTRUMENTS

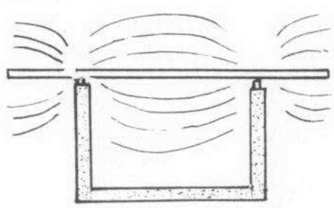
The highest pitched instruments of the traditional gamelan are the Sarons. They are metalophones set over a trough without individual resonators, usually made of bronze or iron. There are three sizes and pitch ranges, given the names Peking, Saron and Demung. Schmidt's corresponding trio of instruments are similar to the traditional models, and he retains the same names. The trough for each is made of wood and sits low on the floor. (With all of the gamelan instruments, traditional and in Schmidt's ensembles, the musicians play sitting on the floor.) The bars rest at their nodes on pads on the rim of the trough. The range of the instruments has been increased to two octaves from the traditional one. Schmidt makes the bars in three shapes, shown end-on below (all are rectangular when seen from above).



The bars are of brass or aluminum. In both cases they are played with moderately hard mallets of balsa wood, or wood wound over with yarn. The aluminum bars produce a light tone with relatively few harmonics. Brass bars are closer in sound and look to the bronze of the traditional instruments. Their emphasis on the high partials is a valuable trait, in Schmidt's thinking, in the upper voices.

That brightness of tone is also enhanced by the fact that the Sarons lack individual resonators for each bar which would bring out the fundamental at the expense of upper partials.

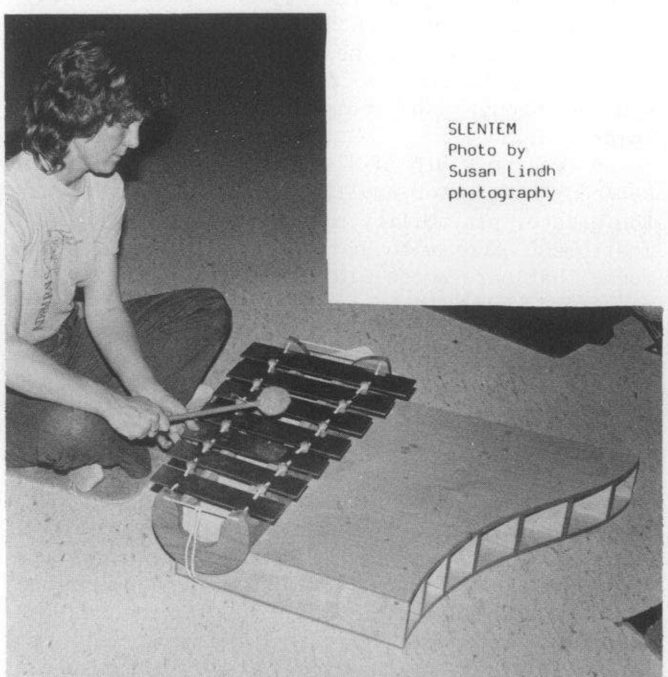
Since any enclosed or partly-enclosed chamber will have its resonating frequencies, the troughs tend to favor some overtones over others. In extreme cases this has the effect of partially cancelling certain frequencies. Schmidt reduces the problem by venting the troughs -- drilling holes in the bottom to break up the standing waves. One can also achieve a similar result by simply leaving off the ends. This has the effect, once again, of encouraging more harmonics and brightening the sound. In spite of all this, the trough does have an important function. When a metallophone bar or marimba bar vibrates, the ends and the middle of the bar are 180 degrees out of phase with one another, creating the potential for some cancellation in the surrounding air. The vibrations in the air above and below the center section of the bar are likewise exactly out of phase (in terms of compression and decompression of the air). The walls of the trough serve to isolate the opposing waves, allowing them to operate without interference.



Isolation of out-of-phase waves (shown in side view of the bar and trough).

INSTRUMENTS WITH INDIVIDUAL RESONATORS

In the Javanese gamelan there are two types of metallophone having an individual tuned resonator for each bar: the Gender, and its larger cousin, the Gender Panembung, or Slentem. Below these in pitch in the traditional gamelan are three sets of large, vertically suspended gongs (smaller gamelan may not have full sets of all three). The Kempul, the smallest of the three (about 38 cm in diameter), appears usually in sets of five or more individual gongs with a pitch range of about 105-150 hz. The larger Gong Suwukan is a set of three or four, pitched around 70-85 hz. The Gong Ageng, usually appearing in pairs, is the largest and lowest, with a diameter of 85 to 100 centimeters and a harmonically complex tone with a fundamental of about 40 to 60 hz.

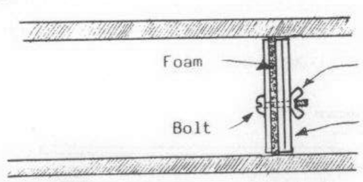


SLENTEM
Photo by
Susan Lindh
photography

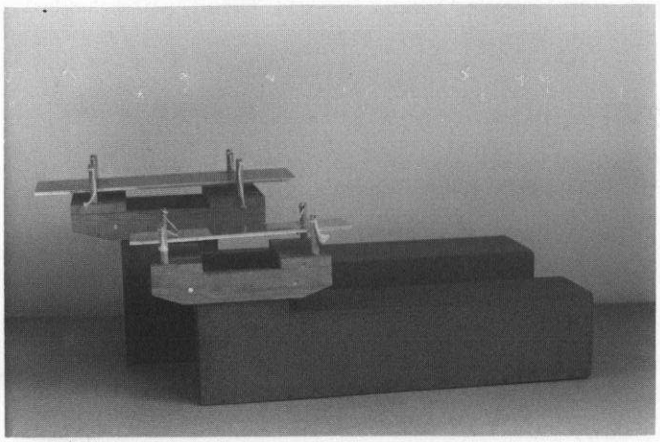
In Schmidt's recreation of this lower end of the gamelan, there are no traditionally-made gongs. For instruments corresponding to both the Genders (the resonated metallophones mentioned above) and the Gongs, he uses resonated metallophones. His genders and the smaller slentems are played with lighter mallets and may have several bars and resonators joined together. The gongs (in the form of metallophones, remember) are played with heavy, soft mallets made of yarn wound over rubber balls. Like the traditional gongs, these instruments are made separately, rather than being mounted in groups in a single frame.

Schmidt uses quarter-wave resonators, meaning that the length of each resonator corresponds to one fourth the wavelength for the frequency of its bar. Quarter-wave resonance is characteristic of resonators that are open at one end and stopped at the other. (This creates a node at the stopped end while the point of maximum amplitude occurs at the open end, thus enclosing 1/4 of the entire cycle within the resonator.) Quarter-wave resonators yield more fundamental and tend to suppress harmonics. This is because while the fundamentals of the bar and resonator are deliberately tuned to reinforce one another, the upper partials of the bar and those of the resonator do not correspond and the same reinforcement does not occur. This helps Schmidt's resonated instruments to yield the pure tone of a near-perfect sine wave.

Schmidt's resonators are made of wood, with an air column that is square in cross section. They are tunable by means of movable stoppers inserted in the end away from the bar. The stopper must have sufficient mass to effectively stop long waves, a smooth and rigid enough inner surface to reflect the wave efficiently, and a seal tight enough to prevent leakage but still allow for sliding to adjust tuning. Schmidt's design is shown below.



Tunability in the resonators is essential. It is the acoustic coupling between the bar and resonator that creates a satisfyingly rich tone; naturally it will only occur if the two are tuned correctly relative to one another. When temperatures vary, the bar and the resonator detune themselves in opposite directions -- the bar flattening as the metal warms up and becomes larger and less rigid, the resonator sharpening as the waves travel faster in the warmer enclosed air. With the movable stopper the resonator can

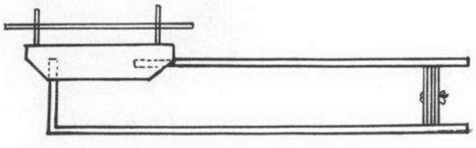


KEMPULS. Schmidts lower-pitched gongs (actually metallophones) are similar to these in design, but longer.

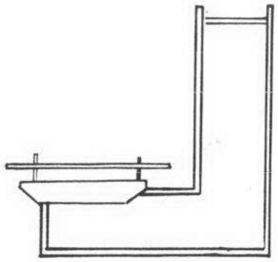
always be retuned to the bar, and the acoustic coupling restored.

The question of coupling can be a tricky one. As marimbas builders know, perfect agreement of pitch between the resonator and the bar actually has the effect of killing the vibration in the bar. The solution is to deliberately detune the resonator microtonally. This allows the resonator to effectively store energy from the bar and feed it back to the bar over a longer period, creating the full richness of the resonated tone and ample sustain. Different builders have different ideas on whether to set the resonator sharp or flat of the bar. Schmidt sets it flat for the practical reason that atmospheric conditions in performance tend to raise resonator pitch and flatten the bar; with the resonator set below to begin with, the two are likely at least to remain in the same ball park.

For the lowest-pitched bar-gongs the resonators are, as one might imagine, very long -- long enough, in fact, that their size and placement present some problems. When Harry Partch built his giant marimba eroicas he was forced to place the players on stools in order to be high enough to reach the bars above the long resonators. Schmidt was reluctant to take this approach, in part, he says, in the tradition of Indonesian gamelan, "sensitivity is great about 'aboveness'". He found that it was possible to orient the resonators horizontally and lie them on the floor, with the sounding bars placed above the resonator, as shown in the diagram.



Orienting the long resonators horizontally on the floor presented another sort of space problem, occupying as much floor space as they did, so in Schmidt's more recent designs the resonators have a 90 degree bend in them.



To continue our description of the gongs in Schmidt's gamelan: the bars are mounted individually in small wooden frames. The frames are independent, detachable units, and fit over the opening on the upper side of the end of the resonator. Within the wooden frames, the bars hang by strings at the nodes from four wooden posts.

The tone of these instruments is extraordinary. It is almost entirely pure and devoid of overtones. Played well with soft mallets, the attack is free of non-harmonic noise. Without seeming loud, the sound is indescribably full, spacious and resonant, and the sustain seems inexhaustible. In the low gong tones especially, for fullness, richness and understated power, the sound is a composer's dream.

TUNING METHODS FOR THE METALOPHONES

Schmidt's approaches to tuning reflect a primary concern with uniformity of timbre throughout the range of the instrument, and a secondary concern with uniformity of appearance. The primary factors governing the tuning of a metallophone bar are weight at the ends of the bar and rigidity at the middle. Shortening the bar or thinning the ends raises the pitch by removing weight; thinning at the middle lowers it by reducing rigidity. Thinning uniformly over the bar's length likewise has the predominant effect of reducing rigidity and lowering pitch. The width of the bar effects amplitude but not pitch as long as the width remains substantially less than the length.

Along with Indonesian builders, Schmidt believes that the greatest uniformity of timbre can be achieved by making the bars uniform in weight, with the weight of the highest-pitched bar actually equal to that of the lowest. This can be achieved by making the higher bars progressively thicker. The manipulability of this variable makes for considerable flexibility in what is probably the most important visual factor, namely, bar length. Schmidt opts for bars of uniformly graduated length over the range of the instrument, with the potential decrease in weight of the shorter higher bars compensated for by greater thickness.

As for the width of the bars, the trade off is between the greater amplitude of the wider bar and the greater playability and convenience in overall instrument size with narrower bars. Schmidt has found that bars whose width is less than about 1/5 of their length leave something to be desired in volume and tone. His procedure is to make the bars progressively narrower in agreement with the progressively shorter lengths of the ascending scale -- that is, keeping the width-to-length ration constant, generally at 1:4 or 1:5.

With pencil and paper Schmidt is able to generate possible workable arrangements -- that is, sets of dimensions which will abide by these rules and produce the desired pitches -- before cutting and machining the bars. He then manufactures the bars and does fine tuning by thinning the bars at the middle or the extremes. This final thinning is kept to a minimum, since great variation or highly irregular shapes is sure to create irregularity of timbre, in addition to being unsightly.

In the end result, in Schmidt's instruments, it is virtually imperceptible visually.

SETS OF HORIZONTALLY-MOUNTED GONGS

In addition to metalophones and vertically hanging gongs, the Indonesian gamelan includes the Bonangs -- instruments made up of sets of smaller gongs mounted horizontally in a wooden frame, without individual resonators. Schmidt's corresponding instrument uses brass or aluminum rimless disks in place of the traditional gongs. (This sort of disk-gong was originated by Paul Dresher, who made them in aluminum.) A hemispherical boss is raised in the middle. This can be done simply by hammering the metal cold. The player strikes the gong directly on the boss.

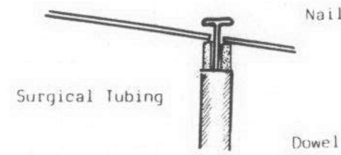
Raising the boss in the disk causes the pitch to rise, as it forces the disk as a whole into a slightly conical shape, making it more rigid.

This is how the gongs are tuned. The rise in pitch as the boss is raised is very dramatic, and the disk seems to sound best at a final sounding pitch about an octave above the original pitch of the boss-less disk. The overtone spectrum of the disks' sound, in contrast to that of the resonated instruments, is rich in partials.

Ideally these rimless gongs vibrate in a circularly symmetrical pattern. The center portion rises and falls as the peripheral portions fall and rise along a circular node at some distance from the center. In practice, this node is usually far from truly circular, following an irregular path as it makes its circumference.

Each disk-gong rests on three or four upright dowels rising from the main framework of the instrument. In the top of each dowel is a small nail or wire brad, with a segment of surgical tubing over it to serve as a pad and prevent rattling. The nails and tubing pass through holes drilled in the disks at points along the nodal circle.

Mounting at the nodes for the disk gongs.

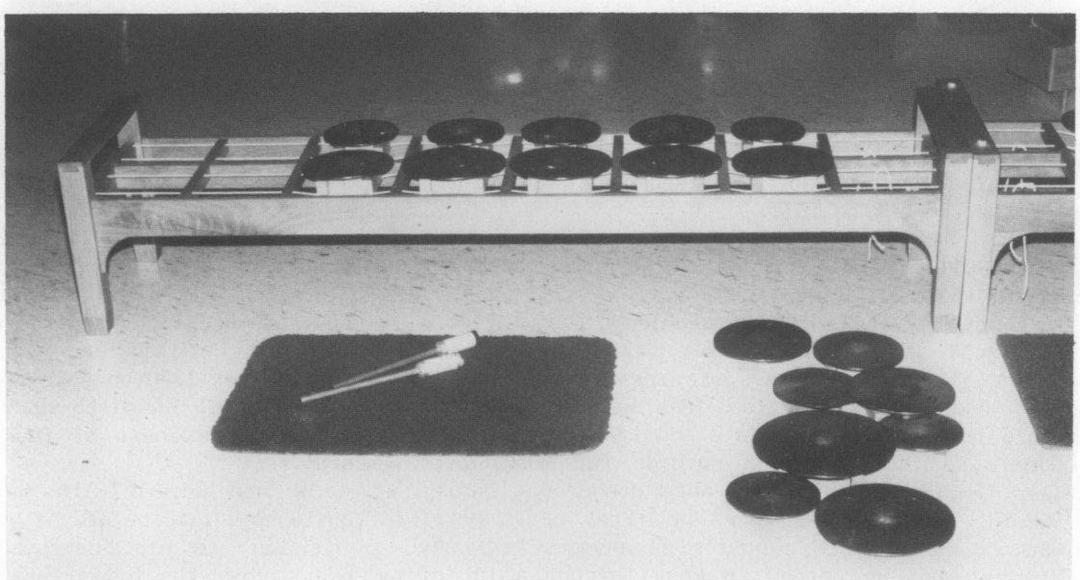


Locating the nodal circle, with its unpredictable irregularities, is difficult. Schmidt uses the technique often used with marimba bars, placing sand on the vibrating surface and exciting it. Where the surface vibrates actively the sand dances around and eventually dances off; at the nodes the sand should remain stationary, and tend to collect there. This test is a bit awkward with the disk gongs though, because the slightly conical shape of the gong makes all the sand want to slide off due to gravity.

INTONATIONAL SYSTEMS

It may come as a surprise to learn that among Indonesian gamelan there is no uniform intonational system. There are two universally recognized scale types -- pelog and slendro -- which are readily identifiable and have consistent characteristics. But, within certain limits, the actual relative pitches of the scales, as they are manifested in the tuning of the instruments, vary from one gamelan to the next. Needless to say, this is not due to a failure of Indonesian musicians to recognize the discrepancies. It arises from an attitude toward tunings and scale systems which differs from ours. Where in Western music we have felt a need to create universal pitch standards and intervalic relationships, Indonesians approve of and appreciate the individuality of each gamelan, regarding it as a valuable aesthetic trait. Indeed, before the construction of a new gamelan begins, the master musician in charge spends some time meditating on possible tunings, arriving eventually at a unique tuning for the gamelan-to-be, which he then communicates to the builder.

This means that an American builder of gamelan has a model to work from if he chooses, but it is a flexible model. Daniel Schmidt has responded to this situation by evolving, and continuing to



BONANG
Photo by Daniel Schmidt

evolve, a system which uses identifiable slendro and pelog scales, but with a mathematical basis in the extended overtone series and just frequency ratios. It is a carefully devised, mathematically precise and rather cerebral system. This may not be the place to discuss it in depth, but certain aspects of its acoustic implications are worth looking at here:

As discussed earlier, Schmidt has substituted low, but definitely pitched, resonated metallophones for the indefinitely-pitched traditional gongs. The tone of these instruments is extremely pure -- essentially devoid of overtone content -- and with soft mallets they can be played with virtually no extraneous noise in the attack. With these gongs as basic material, Schmidt is able to practice what amounts to a natural acoustic synthesis of sound. Playing two or more simultaneously, with carefully controlled relative volume, he can build up timbres as he chooses, in a manner reminiscent of electronic synthesis. On a simple, imitative level, this means that he can approximate the effect of the more acoustically complex Indonesian gongs by playing several selected pitches together. Just as often he uses this approach to create timbres of his own devising.

The specifics of the tuning system become very important in this process. Twelve-tone equal temperament, the tuning system commonly used in the West, uses tempered intervals which, unlike just intervals, have frequency ratios that do not reduce to a simple fraction. For reasons both physical and cultural/psychological, such tempered intervals do not work very well when presented as components of what the ear is to hear as a single timbral mix. With Schmidt's carefully chosen just intervals the ear will much more readily hear a mix of selected pitches as a single timbral blend. With the extremely accurate intonation of Schmidt's instruments, and their rich, lucid tone, that blend takes on the quality of a new sound altogether. The whole is more than the sum of the parts, and it is also very different from the sum of the parts, allowing Schmidt to create a palette of effortless, room-filling, nowhere-and-everywhere sonorities.

Understanding the frequency relationships of his available pitches and their acoustic implications as intimately as he does, Schmidt is also able to work with combination tones in a very deliberate manner. He is even able -- I heard it with my own ears -- to manipulate the phase relationship between two low-frequency bars played together in a slow roll.

SOME ADDITIONAL NOTES ON
MATERIALS AND CONSTRUCTION METHODS

Most backyard workshop people are comfortable with wood. Metal is somehow a little more intimidating. The raw materials are less readily available and their varieties less well understood; tools for working it less commonly accessible and more expensive; and the methods for working it less familiar and perhaps more dangerous. Daniel Schmidt comments that when he first began metal work he was as much a novice as anyone, and only learned what he needed to know through a lot of nosing about, asking questions, and trial and error.

Aluminum, brass and other metals are available in various forms at supply houses in most areas which can be found by asking around, checking the yellow pages and making some phone calls. Employees of large industrial suppliers, which will usually have the best prices and selection, are often surprisingly willing to take the time to talk to the little guy, fill small orders and answer questions.

The materials are generally available in sheets of various gauges, and in extrusions. The word "extrusion" refers to the manner in which rods, tubes and similar elongated shapes are formed. The molten metal is forced through something analogous to a cake-decorating nozzle to create a particular cross-section shape. Materials formed this way can be problematic as vibrating elements in musical instruments, because the extrusion process creates tensions in the metal due to differences in density between the surface and inner material of the piece. Large sheets of metal, on the other hand, are rolled out, and are generally free of such irregularities and inner tensions.

Aluminum and brass are both available in several alloys. The different alloys vary in hardness, workability, and, of course, sound quality. Several alloys of aluminum produce acceptable musical results. Schmidt recommends avoiding the one designated as 7075, which is too difficult to cut. For his aluminum instruments he generally uses 6061 T6, which is not too hard to work easily, but not so soft that it suffers in tone quality or clogs tools. For the brass, Schmidt recommends any of the alloys labeled "half-hard." In practice, there is some variation in the material sold under this designation. All will work well but Schmidt does suggest being sure that on a given instrument the same alloy is used throughout.

Aluminum can be dangerous to work. Bandsaws are the safest for cutting it, and work well at woodcutting speeds, with blades of 6-8 teeth per inch.

A FEW WORDS ABOUT THE MAKER OF THE INSTRUMENTS

Daniel Schmidt's primary work is composing -- instruments are not the thing; they are only tools. But he has always been confronted with the challenge of hearing the sound he wants in his head and having no means of producing it. Earlier in his career, he turned to electronic music to bring the sounds to life, and he has built acoustic instruments all along. In his acoustic explorations he initially worked in a relatively free manner, incorporating a lot of found objects into his work and not emphasizing specific tunings. After 1970 he became increasingly concerned with control of pitch and timbral relationships, and the randomness of found objects took a back seat.

He had worked with metallic percussion for quite some time before he began to apply the label 'gamelan' to his instruments. By that time, he had studied the Indonesian model extensively, and

just as painstakingly, examined his own ideas on composition, timbre and tuning systems. He continues to study traditional Javanese music with K.R.T. Wasidodipuro, and has had extensive contact with performing Javanese musicians.

In addition to his composing and instrument building work, Schmidt currently directs the gamelan at Sonoma State University and the Berkeley Gamelan. He is active on the advisory board of **Balungan**, the publication of the American Gamelan Institute.

FOR MORE INFORMATION...

The best source for information on anything connected with new gamelan music is **Balungan**, edited by Jody Diamond and published three times yearly by the American Gamelan Institute. Subscriptions are $10/year for individuals, $15 for overseas individuals and $18 for institutions, from American Gamelan Institute, Box 9911, Oakland, CA 94613.

Schmidt will build instruments on commission, and he gives workshops and classes in gamelan playing and pitched percussion instrument building. He is interested in receiving scores for gamelan for possible performance by ensembles under his direction. Recordings of music composed by Daniel Schmidt and performed on his instruments are available through the archives of Balungan; contact Schmidt or the archives (address above) for more complete information. Other articles on Daniel Schmidt and his work have appeared in **Balungan** Vol. 1 #2 (emphasizing his approach to composition) and in **Percussive Notes**.

Anyone interested in speaking with Daniel Schmidt about his work may contact him at

1322 Martin Luther King Jr. Way,
Berkeley, CA 94709;
(415) 526-7041.

RECENT ARTICLES, continued from page 20

The Gourd Vol. 16 #2 (American Gourd Society, PO Box 274, Mt. Gilead, OH 43338) contains a brief description of the use of gourds in East Indian instruments ("Indian Gourd Instruments," p.4) and a short letter and photograph showing a gourd dulcimer and another gourd string instrument identified as a yuk, built by Ed H. Carlton (p.10).

PHONIC SCULPTURE: MECHANICALLY ACTUATED MUSICAL INSTRUMENTS IN A SCULPTURAL CONTEXT, by Norman A. Anderson, in **Leonardo** Vol. 19 # 2, 1986 (2112 Berkeley Way, Berkeley CA 94704).

Descriptions and photographs of several electromechanical instruments built by Norman Anderson. The instruments are assemblies of diverse conventional instruments (snare drums, organ pipes, violins, guitars) with various mechanical means of excitation, which automatically play semi-random compositions.

NOTICES

Notices appearing in **Experimental Musical Instruments** are free to subscribers for up to 40 words. For others they are 30 cents/word, 15 words minimum.

Flutist/Recording artist planning extended project recording various experimental and folk flute instruments.
Flute, ocarina, and whistle makers kindly send information with prices to Mark Attebery, 11042 Rock Canyon Ct., San Diego, CA 92126

CALL FOR PAPERS: The editors of the arts journal **Leonardo** are inviting artists and others to submit articles on work involving art and sound. Editorial guidelines may be found on the outside back cover of the journal. Additional information may be obtained from the main editorial office: **Leonardo**, 2112 Berkeley Way, CA 94704. Subscriptions to **Leonardo** are $30/yr from Pergamon Press, Fairview Park, Elmsford, NY 10523.

THE LAB, an experimental performing arts space in San Francisco, is accepting proposals for performances in performance art, music, dance, poetry, film and video. Interested artists should submit proposals to John Di Stefano, Artistic Director, THE LAB, 1805 Divisadero, San Francisco, CA 94115 (415) 346-4063.

THE MAD MOUNTAIN MUSELETTER, news and notes of special interest to string players, luthiers, collectors and enthusiasts published occasionally by MAD MOUNTAIN MUSIC. To receive all mailings FREE OF CHARGE send name and address to: MAD MOUNTAIN MUSELETTER, P.O. BOX 6773, KANSAS CITY, MISSOURI 64123.

From August 18-20 at the Vancouver World's Fair there will be a gathering of gamelan groups from all over the U.S. and the world, ranging from the most traditionally oriented to the least. And lest we forget where it all comes from, the Indonesia pavillion will be presenting Indonesian musicians and dancers throughout the duration of the fair, culminating with a special commemoration of Indonesian independence from August 15-17.

The NEW INSTRUMENTS / NEW MUSIC concert series continues, with its second performance having been presented in early July and the third planned for September. The July performance featured Chris Brown, aided in parts by series organizer Tom Nunn, in a glorious performance featuring Brown's instruments, the Wing and the Gazamba. The coming performance will be on Sunday, September 7th at 2:00 pm at 3016 25th St., San Francisco, CA 94110, donation $5. Featured performers have not been decided yet. For information (including the identity of the performers to appear) call (415) 282-1562.

THE MEGALYRA FAMILY OF INSTRUMENTS
Designed and built by Ivor Darreg

Ivor Darreg is a writer, composer, theoretician and instrument builder from Southern California. In his long and active life he has done everything in his power to advance the cause of microtonality, broaden our musical horizons all around, and generally serve as a thorn in the side of the classical music establishment. Perhaps in a future issue EMI will take a look at the broader spectrum of his work in all its color and variety; for the present, we focus on a particular set of his instruments.

In the article that follows Darreg presents the vital information on his Megalyra family of instruments, and gives the thinking behind the designs. Three instrument types make up the family: the Megalyra, the Hobnailed Newel Post and the Drone. All are steel-string instruments with electric guitar pickups. The strings are stopped with a hand-held metal bar, or "steel," in the manner of a Hawaiian or pedal-steel guitar. The strings and pickups are mounted on flat boards or posts, without separate necks or resonators. Two special characteristics make these instruments noteworthy: The first is that sets of strings are mounted on both, or, in one case, all four sides of the instruments. Aside from serving to balance the string tension on the body, this has the effect of making multiple string-tuning systems available on a single instrument. The second noteworthy characteristic is the emphasis on the use of visual guides in the form of fret-lines painted beneath the strings to indicate where to place the steel for particular pitches. Where the pedal steel has a single set of lines indicating the location of the tones of the twelve-tone equal temperament octave, instruments of the Megalyra family use a graphic marking system designed for flexibility in indicating a variety of just and equal tuning systems. It makes for easy playing in any number of intonational systems, and encourages musical and intellectual exploration of the wider range of tonal possibilities.

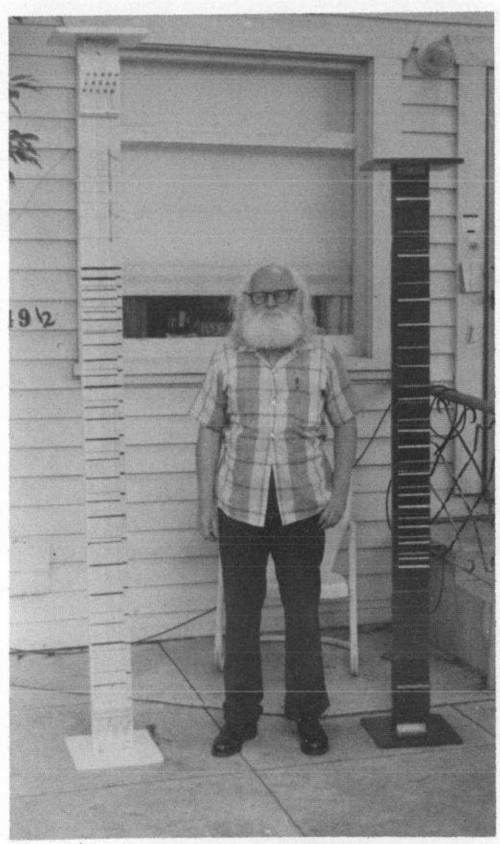
A brief description of each of the three instruments:

The Megalyra is a two-sided instrument of about seven feet long, generally played in a horizontal position with one or the other playing side up. There are sixteen strings on one side, fifteen on the other, arranged in multiple-string courses -- that is, groups of several closely-spaced strings tuned to the same note, intended to be played together to produce a fuller sound than that of a single string. Each side of the instrument has several of these multiple-string, single-note courses. Not only are the individual strings of the Megalyra not played one at a time, but neither, normally, are the separate courses. Rather, all the strings of all the courses on one side are usually played together. Their pitches comprise what is to be heard as a single composite tone in the style of an organ stop which brings several ranks of pipes into play. The steel bar used to stop the strings at the desired length is, accordingly, made to cross all the strings at once, and the tuning of the strings is selected with traditional organ stops in mind so as to be appropriate for the composite tone. As one might imagine, between the great size of the instrument and the chorusing of so many strings, the tone of the Megalyra is most impressive.

The Drone could be considered a smaller version of the Megalyra -- a two-sided instrument of about five to six feet long, designed for a slightly higher range and perhaps less imposing tone. On one side are twelve strings tuned to produce a single composite tone as on the Megalyra; on the other are a smaller number of individual strings tuned to a scale.

The Hobnailed Newel Post is smaller and may be played either upright or on its side. The body of the instrument is a four-by-four post, with twelve to sixteen strings mounted on each of the four sides. Less emphasis is placed on obtaining the great big sound of multiple strings here: the primary purpose of the Newel Post is versatility and flexibility in available harmonic systems. According to the tuning of the strings and the placement of the visual fret-lines, a different harmonic system of the player's choice can be available and accessible on each side. There is no standard tuning; Newel Posts may be tuned and retuned, and their fret-line patterns altered, to fit the purposes of an individual player or a particular performance.

IVOR DARREG WITH THE MEGALYRA AND DRONE



Non-commercial recordings of these instruments are available from Ivor Darreg at 4028 Boundary Street, San Diego, CA 92104. In addition, Darreg has available a great many other publications of interest to instrument builders and theoreticians, including frequency, cents and fret placement charts for many just and equal tuning systems. The instruments described here as well as others can be built on commission or are available for rent or exchange, and Darreg also does guitar refretting for special tunings. Write him for more information. Here, now, is his article.

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MEGALYRA, DRONE, AND NEWEL POST
By Ivor Darreg

The Hawaiian or Steel Guitar has been around for about a century now. According to a dictionary of Hawaiian music, one Joseph Kekuku discovered how to slide the back of a knife-blade along the strings to get the gliding effect. However, there are other claimants to the invention, among whom James Hoa and Gabriel Davion were mentioned in that dictionary. Some writers have supposed that the idea was suggested by voyagers who had heard a similar effect in India. There is some plausibility to that.

During the thirties, at its half-century mark, there was a surge of Hawaiian-guitar popularity, brought on largely by the development of magnetic pickups and amplification. Now this method of producing musical tones could compete in volume with the other instruments in a band, and in turn,the resulting popularity of steel guitars promoted the idea of amplifiers. Since then, the steel guitar and amplification has been closely associated in the public mind -- except for the Dobro and a few special instruments of that genre, steel guitars are always amplified.

The late Leopold Stokowski mentioned the advantages the flexible tone of the Hawaiian steel guitar would bring to the regular symphony orchestra if it were admitted there, but nobody ever took him up on that. Well, what would you expect from the hidebound Musical Establishment? Open arms!? Now really.

I bring this up because I want to explain my motivations in developing the Megalyra Group of Instruments. I was started on conventional music training over fifty years ago -- piano, organ, and cello -- and took part in choruses, ensembles, and orchestras. I saw and heard the limitations of conventional instruments. Then and there I was determined to do something about it, but that took decades, not just years.

"Find a need and fill it" -- frequent advice to inventors. What does the conventional orchestra lack? Power in the bass. What's the matter with the pipe organ, and its successor, the electric organ? They have power enough in the bass, but they are too rigid. All they can do is turn notes on and off. Nearly all keyboard and fretted instruments are rigidly tied to the 12-tone equal temperament tuning. The new synthesizers have it built into their vitals. The steel guitar, on the contrary, can play any gradation of pitch whatever, just like the human voice. Its frets are mere painted or inlaid lines on the board underneath the strings and function only as guides.

But we must be fair : What's wrong with the regular steel guitar? It hasn't progressed. It has been held back for decades -- for a while, it almost faded and went out of the picture. Decade after decade went by, during which it was used for syrupy mawkish trivia. The older models were tuned to an A-major-chord -- no way to get an augmented triad or diminished seventh tetrad out of that! You had to retune it if you wanted minor scales. Then how would you play a major chord? A few models appeared with two necks to get around that. Then a while ago somebody thought up the Pedal Steel. Call in the bicycle-maker and a sewing-machine mechanic, and put in various gizmos to tighten and loosen the strings so that the tuning can be rapidly changed. Also put more strings on for variety. Ingenious; and it does work for country music and similar styles. But it's complicated and expensive. And a considerable portion of the standard guitar strings' length is "eaten up" by the Pedal Steel's tightening and loosening mechanisms that the pedals and knee-levers operate on to change the tuning.

In particular, the bass strings do not have enough actual useful sounding-length, as compared with a conventional Spanish guitar. You can make up for this with amplification, but there is really no substitute for long bass strings, as any one who hears a concert grand immediately realizes. Getting back to the pipe organ mentioned above, what does it have that the ordinary steel guitar doesn't enjoy? Why, depth and dignity. Great depth but still ringing brilliance. So what did I do? Think Big. What if a steel guitar were made four times the size?

I had a board 205cm (6ft 8ins) long. I fitted it with pin-blocks, tuning-pins, bridges, pickups, and strings. Room for fifteen strings on each side. Why both sides? To balance the tension so the long board wouldn't warp. Otherwise one would need a heavy metal beam and careful bracing: we are talking about tons of tension here. For the tones to sustain, the strings must be massive enough to store energy. But if they are thick enough, then they must be tightened until they behave as strings, rather than rods. The right size and tension were arrived at by examining various instruments, all the way from ukuleles to pianos. My forty-six years of piano tuning, applying such tension, was a help too. Experiments determined the average breaking point of the music wire used, and so the factor of safety to allow. That gave the maximum sounding string-length on one of the instrument's sides.

For example, the designs for both the Megalyra Contrabass and the full-size Drone instrument call for several strings in unison sounding Tenor C 132 Hz. So the natural question was, what is the longest string that will sound Tenor C without breaking frequently? Experiment showed that for thin steel wire of the kind used for first or second strings, on guitars, that the length was

160 cm or 5 feet, 3 inches. Some of the strings tested would withstand Tenor E-flat 156 Hz before breaking. Memorize this, it's useful to store in the back of your mind: Doubling the frequency, or taking the pitch of a string up an octave, requires QUADRUPLING the tension! Twice the tension raises the pitch half an octave. The minor-third factor of safety just considered, then, comes to about 1.4 times the tension to go from Tenor C to E-flat above, about 1/4 octave. You might feel more comfortable playing safe and settling for a shorter Tenor C of 152cm (5ft) long. But if the strings on a Megalyra or Drone are too loose, several disadvantages appear. They do not stay in tune as long, and they give under the steel or wooden bar too much. Moreover they lack the snap, fire, and brilliance that set these new instruments above the dull plane of trivia.

There are no stock strings suitable for the Megalyra -- you will have to make them out of steel music wire. Sizes will be given at the end of this article. Similarly for the Drone if it is to have a wide compass and the timbre of long strings. The Newel Post can be designed with shorter strings, so that the standard guitar strings will be long enough for it. On the Megalyra and Drone I used loop ends rather like those used on harpsichords and banjos. These are easy to make and books on harpsichords usually tell how to.

Since we are using high string tension and many strings (a full size Megalyra needs about 30 strings, and a Drone 20 to 24), the gear heads used on guitars will not stand the tension and would cost a fortune. So I recommend regular piano tuning-pins which can be placed fairly close together and and tuned with standard tools. If a pin becomes loose, there are larger sizes for replacement. The much smaller tuning-pins used on zithers, harpsichords, and clavichords are not suitable for the heavy wire that will be used on the Megalyra, although you might use them on a Newel Post. Generally a Drone Instrument should have fairly heavy wire for some strings. The tuning-pin-blocks are traditionally made of five-ply maple or other hardwood, but this can be very expensive. We won't be using the very high tensions found in a piano, such as 170 lb (77kg) but more like half that tension, so can get along with less expensive plywood. For the common fir plywood, the holes should be somewhat tighter than the standard size for maple. About one-half the length of the threaded portion of the tuning-pins will traverse the pin-block -- the rest goes into the main board. Drill the holes clear through.

To avoid weakening the board or beam, the pin-blocks for the two sides should be at opposite ends of the board, even though this means having to tune one side at one end of the instrument and the other side at the other end. (In case of the 4-sided Newel Post, of course, two sets of tuning-pins should be set at right angles, not opposite to each other, and the other two sets at the other end.) The hitch-pins or other fastenings must be staggered with respect to the tuning-pin block opposite it again not to weaken the board. If the strings on opposite sides are the same length, they must be offset considerably for similar reasons.

Many popular designs will require different string-lengths, and this turns out to be more of a solution than a problem. For example, the usual Megalyra design will make the strings on the bass or accompaniment side much longer than those on the solo or melody side. This automatically solves the problem of fittings on one side being opposite those on the other.

For the Megalyra Contrabass there should be from three to five strings for the principal "courses" as some luthiers call groups of strings. The full array is: 5 strings on Contra C 33 Hz; 5 strings on Great C 66 Hz; 2 strings on Great G 99 Hz; 4 strings on Tenor C 132 Hz. This is for the solo or melody side. This is derived from the traditional appointments of the Pedal Organ in a large organ, so it has been tested out for some centuries. The steel is ordinarily laid across all these strings and they are strummed at once to produce a compound tone having the 1st, 2nd, 3rd, and 4th harmonics in suitable proportions. This is how you can get both brilliance and depth. Also, you get a Chorus Effect, as you do with 3 strings to note on the piano, or several ranks of pipes in the organ. On the Bass or Accompaniment side of the instrument, there should be five each of strings tuned to Contra C 33 Hz, Contra G 49.5 Hz, and Great C 66 Hz. There is a space left between the groups of course, so that so that one can play one group without sounding the others if desired.

The tuning of the Drone will vary with the user. My scheme is to have eight very thin strings in unison to Tenor C 132 Hz and a slightly separated group of four thicker strings for Great C 66 Hz next to them -- in all twelve strings on the melody side for a rich chorus effect and the ability to play in octaves when needed. A special bridge can create a sitar-like buzz for this portion of the instrument. These pitches are for a Drone five to six feet (say 150 to 180 cm) long. For a shorter drone how about F or G above those C's? The Drone strings themselves can be on the backside of the board or divided between the other two sides. For five drone strings, a pentatonic scale C D F G A would be suitable. For a sixth drone add a B-flat.

The tuning of the Newel Post's 4 sides becomes a personal matter, just as the tuning and pedal layouts on the Pedal Steel are highly individual, so not much use giving details here. I have just-intonation chords and use major, minor, harmonic seventh, and minor seventh, as well as a harmonic-series or minor-ninth chord. Your choice will depend on whether you want a performance instrument or a Composer's and Arranger's Studio/ Harmonic Laboratory. Thousands of variations are possible, even with the same stringing. Twelve to sixteen strings will be on each of the four sides, spaced as you desire.

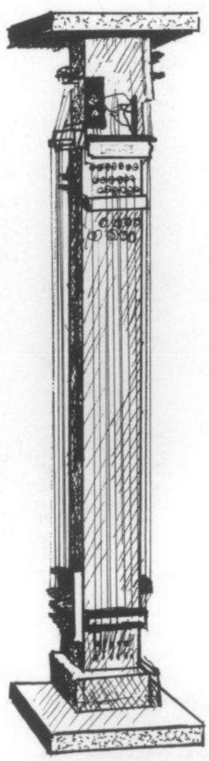
The steel used on these instruments can be a rod or thick-walled tube preferably somewhat longer than the width of the board. Also you will

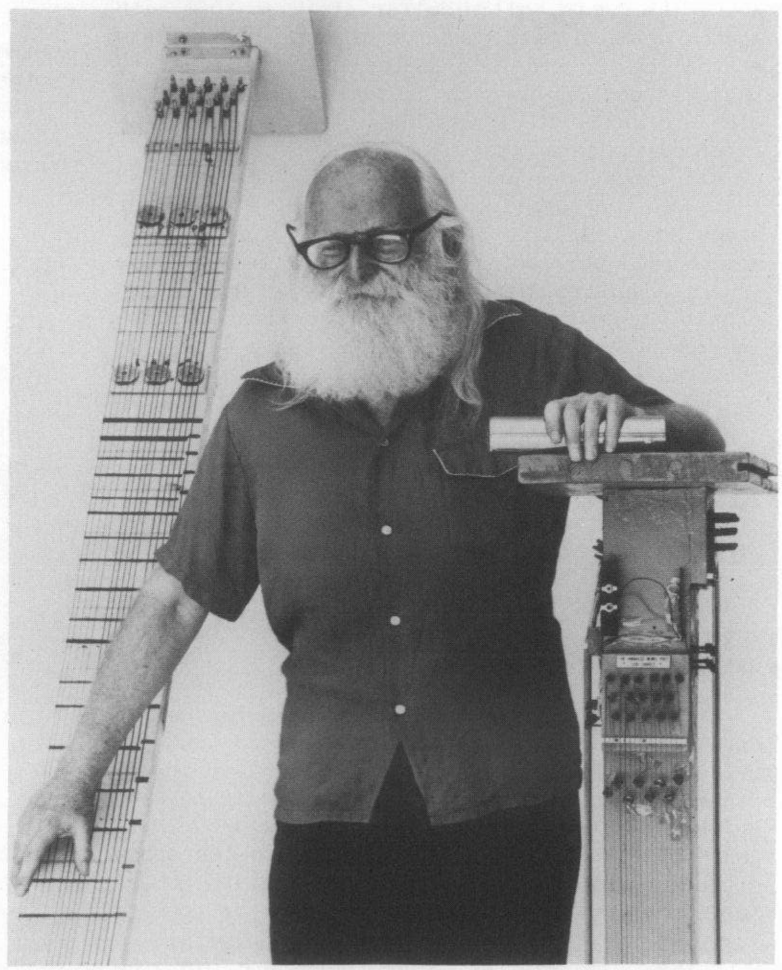
need a pair of wooden bars about as big as hammer handles or broomsticks. When you do not want the gliding or sliding effect of the steel, take up a wooden bar in each hand and strike all the strings on the solo side simultaneously, using right and left hands in alternation for a clear-cut articulation of the notes without sliding between them. One reason for using both hands is to prevent undesirable ringing of the open strings between notes. The wooden bars must be held down firmly while each note sustains. With practice you can play quite rapidly.

All these instruments require amplification with magnetic pickups. Each side of the Megalyra requires two pickups, placed at about one-twelfth and one-sixth of the open-string length respectively. The Drone Instrument can get along with one pickup for the melody strings and one for the drone strings. Each of the four sides of the Hobnailed Newel Post can have one pickup, which should be located near the bridge -- say one-fifteenth of the open-string length, to pick up the high harmonics. On these instruments played with a steel, we have to take precautions not to pick up too much of the sound from the portions of the strings on the far side of the steel. A small amount of such tones will not matter, but they must be kept down. Muting with the hand or having a felt muting-strip glued to the steel might help.

All these instruments in the group use a pattern of visual fret-lines as a guide to the player. Before the bridges are fitted, the board should be painted with the ground-color of your choice. If you prefer a natural finish, it can be coated with one of the new heavy transparent finishes. On top of this the fret-line patterns are painted over a range of two octaves. For the Drone, only the melody side bears the pattern; for the Megalyra, both sides have it; for the Hobnailed Newel Post, all four sides. Tables indicating the fret-placement distances for a variety of string-lengths are available from the author. Briefly, the standard pattern is as follows: A row of green lines (unless the ground color of the instrument is green) is laid down for the conventional 12-tone chromatic scale. Alongside that first row, a second, multi-colored set of lines is laid down delineating an untempered just scale. It is made up of a row of black lines (white in some cases) for the naturals, red lines for the sharps, and blue lines for the flats. Beyond these patterns extends a set of yellow or orange lines clear across the width of the board, showing harmonic nodes. On the Megalyra it is worth the trouble to carry the harmonic markings up to the sixteenth harmonic since the long strings will clearly sound them and with four or five strings tuned to Great C you can do a chord of harmonics in your demos. On the Drone take them to the

At right: DARREG WITH THE MEGALYRA AND NEWEL POST
Below: THE NEWEL POST





tenth, and there should be room on the Newel Post for up to the eighth.

The pickups may hide some of these markings, of course. To alleviate this problem, you might have the markings at the pickup area extended to the edge of the board and leave out the center portion where you know the pickup will be installed.

The fret-lines may be painted on with a sign-painter's brush. On the Newel Post where the lines have to be narrower, you can use the colored draftsmen's charting-tapes available in various widths. Another possibility is to rule the lines on a plastic or special drafting sheet, which is later secured to the board. (It is recommended that you place the conventional 12-tone and the just markings in some permanent fashion; if you want to have charts of other tunings such as 19- or 31-tone, they can be on overlay charts). Don't wear yourself out trying to be over-precise; these lines have to be much wider than the real frets on a guitar. The steel can't be placed with great accuracy -- correcting is done by ear.

Before the bridges are attached, you can rout channels for the wires to the pickups. Or if you like, do the wiring on the surface. I made my own pickups (details on request) but if you prefer commercial pickups, low-impedance types are recommended. Bring the wiring from where the pickups will be installed to a terminal strip at the end of the board, using different colored wiring to be able to trace connections later.

The Megalyra strings should be one inch (2.5cm) above the board, allowing for striking them with wooden or metal bars, and for playing with mallets if the regular steel is used. On the Newel Post, the strings can be much closer on the board, as with ordinary steel strings. The Drone is an intermediate case.

All these instruments must have end-pieces so that when they are laid on the floor, a table, or stand, the strings on the bottom side of the moment will be clear of the floor or table. I use square endpieces from ten to twelve inches square (25 to 30 cm square). This permits standing the instrument on either end and provides a place for jacks or even an onboard preamp.

One reason for treating these three instruments together is that hybrids are possible, as well as further variations of the basic idea.

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SIZES OF WIRE USED IN THE MEGALYRA INSTRUMENTS

(These figures are for high-carbon spring-steel music wire of the kind used for pianos, guitars, harpsichords and the like.)

The special Music Wire Gauge system for designating wire diameters is being phased out. We give the numbers here, but usually at a hardware store they will want you to identify what you want by diameter in thousandths of an inch. This is just as well: Music Wire Gauge runs in the opposite direction to the American and British gauges for other kinds of wire, such as B&S for copper.

MEGALYRA. The figures given here are for the average size Megalyra seven feet (231 cm) long. Shorter instruments may use the next size larger.

Contra C	No. 22	.049"	1.25 mm
Contra G	No. 17	.039"	.99 mm
Great C	No. 12	.029"	.74 mm
Great G	No. 8	.020"	.51 mm
Tenor C	No. 3	.012"	.30 mm

DRONE. These figures are for an instrument of 5-1/2 to 6 feet long (183 cm). Shorter drones will use larger sizes.

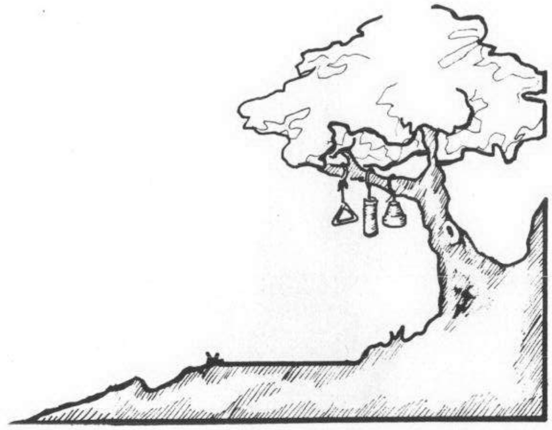
Great C	No. 12	.029"	.74 mm
Tenor C	No. 3	.012"	.30 mm

NEWEL POST. Nearly all Newel Posts will be about the length of a large guitar, and will be capable of using standard guitar strings, although the actual sounding length on one or two of the four sides will be somewhat greater than the standard 650 mm (25-5/8"). Wound strings are required for the lower notes and plain for the higher, and all these sizes are widely available at music stores. Some strings are shorter than usual and may have to be extended by threading a steel-wire loop through the loop or the ball end. Figure on a somewhat higher tension than the guitar normally uses. N.B.: You may have to drill some of the tuning-pin holes out larger to pass some of the wound strings through!

TUNING-PIN SIZES

Size 1/0 appears in lengths of 2" and 2-1/2". All others are 2-1/4", 2-3/8", and 2-1/2". Size 2/0 is the one usually installed in pianos at the factory, so they can often be obtained from junked pianos.

SIZE	DIAMETER -- THOUSANDTHS OF AN INCH	DIAMETER -- MILLI-METERS
1/0	.276	7.01
2/0	.282	7.16
3/0	.286	7.26
4/0	.291	7.39
5/0	.296	7.51
6/0	.301	7.65



Experimental Musical Instruments regularly reports on organizations or periodicals that are of potential interest to readers. In connection with the article on Daniel Schmidt's new gamelan instruments, we devote this issue's column to the American Gamelan Institute and its publication, **Balungan**. More background on gamelan music in general may be found in the Schmidt article.

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THE AMERICAN GAMELAN INSTITUTE and its journal, BALUNGAN

In recent years there has been increasing interest in gamelan music outside of its native Indonesia, with gamelan appearing in increasing numbers in the U.S., Europe, other parts of the Pacific and far east, and elsewhere. Many of these new ensembles are devoted to the faithful performance of traditional Indonesian gamelan music, while some (in what was initially a difficult and controversial step) have evolved musical styles based in but distinct from traditional forms.

With the growing interest in gamelan in the U.S., the American Gamelan Institute was founded in 1981 by Jody Diamond. She opened an independent studio in Berkeley, California, and, using an American Gamelan built by Daniel Schmidt, offered classes in Javanese music and group improvisation, as well as concerts and workshops. A.G.I. also sponsored two summer programs in music, dance and composition, which included classes in the traditional music of Java and Bali, Balinese dance, instrument building, and composition for gamelan. In 1983, Diamond formed the performing group **The Diamond Bridge**, now B.A.N.G. (Bay Area New Gamelan). The Berkeley studio of A.G.I. was closed in 1984, when Diamond began teaching at Mills College and became the director of the Mills College Gamelan.

Currently, A.G.I. is sponsoring two community classes in Javanese and Sundanese gamelan, the first taught by Diamond, and the latter by Henry Spiller. (For information, call Jon Grasse at (415) 534-3880). There has been a steady growth in archive sales (write for a catalog), offering music from gamelan groups around the U.S. and, soon, from Indonesia as well. Two of **Balungan**'s staff members, Joan Bell Cowan and Linda Dobbins River, are teaching and developing gamelan programs for children.

A.G.I. is also coordinating an ongoing "Performing Arts of Asia" series -- gamelan from Java, Bali and Sunda as well as music from the Phillipines, Cambodia, and elsewhere, accompanied every week by a delicious Sunday brunch at Tuti's **Dutch East Indies** restaurant in Oakland, California (call (415)444-9358 for reservations and program information). Presenting gamelan music and food together in this comfortable setting helps to realize one of the original goals of the American Gamelan Institute: to make gamelan music an integral and accessible element of our own community.

Since 1984 the American Gamelan Institute has published the tri-annual journal, **Balungan**, an international gamelan journal for both scholars and composers/performers involved in gamelan and related arts. In addition to encouraging a dialogue between scholars and artists, **Balungan** establishes a communications network for gamelan people in the U.S. and abroad, and provides for the archiving of the increasing number of gamelan-related compositions, recordings and writings. Jody Diamond is the editor; Larry Polansky supporting editor, and the remaining staff and advisory board include a healthy mixture of leading figures in both traditional and new gamelan. The following description of the publication and its purposes is taken from its informational flyer:

Balungan is a publication dedicated to gamelan, the gong-chime orchestra of Indonesia. Special features cover the music, dance, and theatre of all the Indonesian islands, related ensembles in Southeast Asia, and new forms being created by artists in Asia and the West.

Balungan also serves as a network linking groups and individuals in the United States, Canada, Sweden, England, The Netherlands, Germany, New Zealand, Australia, Japan, the Phillipines, Taiwan and Indonesia.

Balungan takes its name from the Javanese word for the melodic framework that guides and connects the gamelan instruments, smoothly uniting diverse elements.

The function of **Balungan** is to support both the academic and artistic approaches to gamelan and other Asian arts. Each issue contains articles, interviews, scores, letters, information on instrument building and technique, new archive holdings, and concert programs.

A small sampling of recent articles appearing in **Balungan** includes one on tuning systems in American gamelan, by Larry Polansky; one on an elementary school gamelan program by Barbara Benary; a listing of gamelan in America; scores by Lou Harrison, Jody Diamond, Daniel Goode and others; and a liberal complement of interviews, reviews and the like. **Balungan**'s articles are generally clearly written, informative and interesting. The layout, with its appealing asymmetries and a headline type style that manages to look like the hammered bronze of a gong, is satisfying and pleasing. Issues normally run to something under thirty pages.

Subscriptions to **Balungan** are $10/year (three issues) for individuals, $15 for individuals overseas, and $18 for institutions. Back issues are $5 dollars each. Mail should be addressed to Box 9911, Oakland, CA 94613; make checks payable to the American Gamelan Institute.

Also available from the American Gamelan Institute is a cassette tape of the Bay Area New Gamelan (instruments built by Daniel Schmidt) performing pieces by Schmidt, Jody Diamond and Ingram Marshall. The price is $7 plus $1 postage from the address given above.

SIX UN-INVENTED INSTRUMENTS

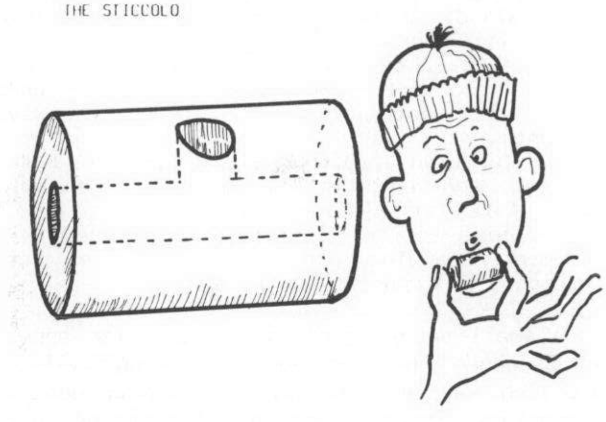
By Tim Olsen

Here are descriptions of six fanciful instruments conceived by Tim Olsen. In spite of their whimsical nature, they may not be entirely impractical: Tim has made a working sticcolo, and at one time did some preliminary work on a stompano. He reports having once seen some thing like a selpreg in the hands of guitarist Eugene Chadbourne.

Tim Olsen is publications editor for **American Lutherie**, the journal of the Guild of American Luthiers, and a luthier in his own right.

THE STICCOLO: A tiny form of transverse flute, made from a small chunk of almost any material in almost any shape. A lateral bore through the chunk forms the main air column; it is joined by a short vertical bore which provides the blowing edge. The instrument is held in one hand and blown like a flute while the two open ends are stopped, partially stopped or left open by the thumb and forefinger.

THE STICCOLO



In terms of construction, the Sticcolo is certainly among the simplest of all instruments, yet one with considerable musical possibilities, given a player with a ready pucker and nimble knuckles. To build a Sticcolo, simply choose a lump of material which fits amenably betwixt thumb and forefinger; wood, plastic brass or silver are recommended, but gold is also acceptable. The cylindrical shape is normal for said lump, however design parameters are wide. The Sticcolo is born when the juncture of the longitudinal and dorsal borings delineate port and starboard fingering holes as well as mouthpiece.

Though the highly portable Sticcolo has but three fingered tones (open, starboard, port and starboard), it affords a smooth glissando between all points. Microtonality in a vest pocket! Furthermore, by holding a different sized Sticcolo in either hand, a person might even be able to shriek out a tune.

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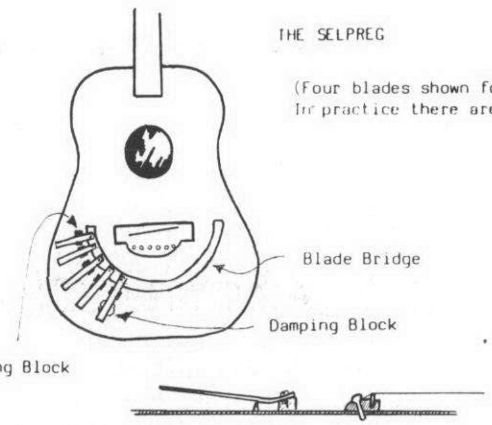
THE SELECTIVE PREFERENCE GUITAR: A conventional guitar modified by the addition of several metal lamellae (old bandsaw blades may be used) mounted like the tongues of a sansa on a semicircular bridge below the normal bridge on the lower bout. The tongues are tunable or, alternatively, may be individually damped, allowing them to serve selectively as resonators for chosen pitches.

THE SELPREG



The Selpreg (as it is sometimes called) represents an alternative to sympathetic strings, so Mahavishnu John take note. Also, and more importantly, it offers a potential use for those pesky outworn bandsaw blades.

A J-200 or Guild F-50 make likely victims for conversation to Selpregs, as they are already built as sturdily as pianos and have a lower bout soundboard area suitable for tank maneuver. The blade bridge is the only thing you will need to attach to the sound board, as the tuning and damping blocks are held in place by the downward pressure of the blades.

By tuning the blades chromatically and judiciously selecting those left free to ring, the Selpreg can be given a preference for certain notes or keys. Or you may tune the strings to perform a droning function, hold the peghead between your feet, and pluck the blades.

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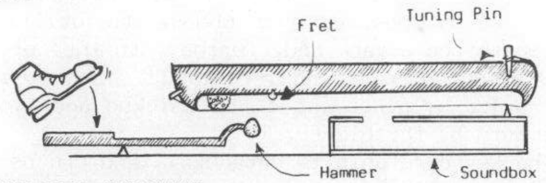
THE GREAT PEDAL CLAPICHORD: The Great Pedal Clapichord is an extrapolation of the clavichord which allows the use of extremely long strings and yields terrific sustain; also, it is an instrument designed to give grand piano manufacturers something to mess with since Frank Hubbard drove them from the legit harpsichord arena. Good work, Frank.

In form it is a giant, pedal-operated string instrument. The pedals activate hammers which slam a string against a board with one fixed fret, like the hammer-on technique sometimes used to sound conventional fretted strings. But the clapichord is designed with the greater mass and strength required to excite very long, heavy strings. The main body of the instrument is a massive iron harp which supports the string at both ends and provides for tuning mechanisms.

Also mounted to the harp is a wooden frame containing the hammer action and the soundbox. Because of the height of the fret, there is room for controlled pitch bending, as the force of the hammer can stretch the string a lot or a little by pressing the string close or not so close to the board.



THE GREAT PEDAL CLAPICHORD

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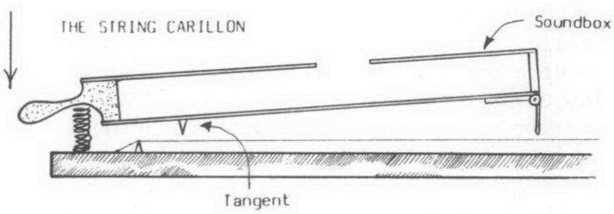
THE STRING CARILLON: A string instrument in which a series of soundboards and boxes are placed above a set of long, massive strings set on a separate frame. Each soundboard and box is mounted with its own a spring-and-hinge arrangement. There is a tangent or fret on the face of the board, and a handle at one end. The player uses the handle to pivot the whole assembly downward, slamming the tangent against one of the strings to produce the tone. To enhance the carillon effect, the instrument can alternatively be set up so that each board contacts several strings, producing a grander tone. The strings may then, at the builder's discretion, be tuned to replicate the overtone and undertone mix of the giant bells.

THE STRING CARILLON



Like the Great Pedal Clapichord, the String Carillon is a transmongrification of the Clavichord action; this one, however is unusual in that the entire soundbox is brought into forceful contact with the strings. The playing style is similar to that of a bell carillon, with the notable exception that sostenuto can only be achieved by holding the handles down. Also it is fruitless to attempt mounting a String Carillon in a belfry. Or anywhere perhaps.

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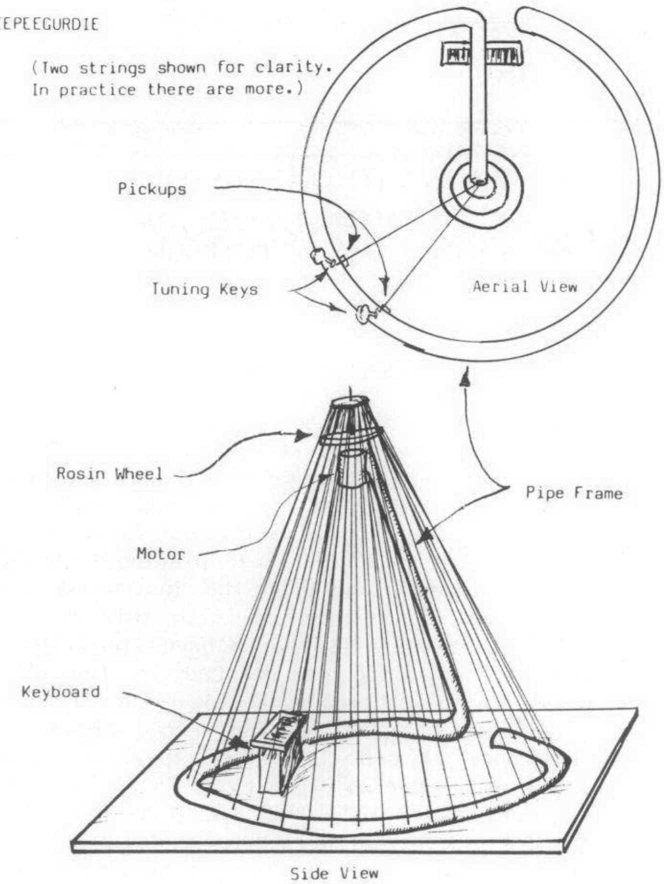
THE TEEPEEGURDIE: The Teepeegurdie, brainchild of Bob Petrulis, is basically a motor-assisted conical electric hurdy-gurdy of heroic proportion arranged on a piece of minimalist tube sculpture. It is ideal for those who like to "really get into" their musical instruments. In fact, with the Tolex dust cover in place, it forms a snug personal habitat for the orchestral bivouac.

Basically, the instrument is an arrangement of strings, similar in both size and shape to a teepee. The framework is a rigid metal tube which makes the circumference of the teepee shape at ground level, then traverses up to a the high point at the center above. 50-60 long strings are mounted on the tube, fanning out from the top and attaching below at the perimeter. Just below the top point where the strings meet is a motorized rosined wheel which contacts the strings, sounding them all as it rotates. At the lower end of each string is a pickup. A keyboard set someplace within this tent of strings switches individual pickups on and off, determining which of the continually vibrating strings will be heard when.

TEEPEEGURDIE



The other salient features of the instrument include a manual rosin-wheel disengagement lever and an all-pickups-on pedal. With the latter two features activated, the Teepeegurdie operates as an immense electric harp, which engulfs the player.

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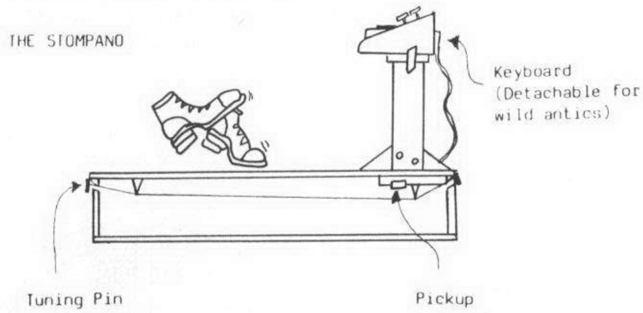
THE STOMPANO: This conceptually unusual instrument can be visualized as an inside-out zither with individual-string pickups actuated by a remote keyboard.

The main element is a platform with a bank of strings mounted on the underside. Vibrating energy is imparted to the strings by the Stompanist dancing on the "soundboard". Each string has its own pickup, and a keyboard similar to that described for the Teepeegurdie above allows the player to control which of the strings will be heard when.

The Stompano uses no damping mechanisms, making construction somewhat basic. With all strings excited simultaneously, cacophony would result with an acoustic instrument, but electrification on a note-by-note basis cures this nagging problem.



The Stompano offers the musician two important breakthroughs for keyboard string instruments: crescendo, and maximal body language. Dynamic range is its main attribute.

The excitation of the string may occur either before or after actuation of the note, and may continue for the duration of the note or not. Thus, it is possible to choose to utilize or eliminate the attack and, further, to then proceed to diminuendo, crescendo, or trill. Tone color is controlled by placement of the pickup and type of shoe worn by the player.

The keyboard unit is detachable and can be worn with a neck strap, giving the sought-after look of tap-dancing accordionist.

INSTRUMENTS WITHOUT HISTORY

THE DIFFICULTY OF GAINING ACCEPTANCE FOR INSTRUMENTS WITHOUT EXISTING REPERTOIRE, ESTABLISHED TECHNIQUE OR TRAINED PLAYERS

By Bart Hopkin

If the violin had never existed and someone were to invent it fully formed tomorrow, it might not succeed in gaining acceptance. For, as magnificent a piece of equipment as it is, without its surrounding tradition it is a clumsy thing. Two broad elements of the culture of the violin are essential to the realization of its magic. The first is the existence of the highly refined playing technique which has evolved along with the instrument over the centuries. In conjunction with this we have the availability of players who have spent years, working with a diligence matched in few other fields, learning to bring forth the sweetest sounds the instrument can produce. The second element is the existence of a rich violin repertoire, also developed over a period of centuries by a long line of composers. Along with the repertoire there has developed a widespread, well-developed appreciation of what the instrument can do in skilled hands, what it is good for and how it can be shown off to greatest advantage.

Imagine what the situation would be if one were handed a hypothetical newly-invented violin without the benefit of these traditions. It is no secret that a violin in the hands of a beginner is not a pleasant thing to hear. The intonation sets the teeth on edge, and the timbre recalls the title of a Tennessee Williams play. It takes months, at least, to begin to bring these things even partially under control. But in this imaginary situation, confronted with the instrument in a cultural vacuum, one would have little sense of how long it would take to overcome the problems, or indeed whether they can be overcome at all. More importantly, one would have no notion of the world of sound that could open up with years of well-directed practice. The player probably wouldn't even wonder about these things: he would simply hear a painful screeching as he dragged the bow across the string, and quickly decide that there are better ways to spend the day.

Of course, the violin did not appear fully formed and awaiting acceptance. Centuries of gradual development, in which the musical tradition evolved jointly with the physical instrument, earned the violin its current acceptance and put it in a position to fulfill its potential. But other newly-invented instruments may find themselves in a position like that of the hypothetical violin-invented-in-a-vacuum. This is especially true for instruments which do not closely resemble one of the familiar standard instruments. The new-born instrument appears without repertoire to play and without skilled performers to play it. Listeners and first-time players have no way of knowing what the instrument can do. If they don't hear something attractive right away, it just might not occur to them to wonder what more is possible. No one is likely to consider the possibility that, given the amount of practice normally given the violin, the new instrument might reveal an undiscovered world of beautiful sound. And it is still less likely that anyone would undertake the project of developing a slowly and painstakingly acquired skill in blind faith.

OK, so what is the upshot of all this? Do we conclude that instruments which depart strongly from tradition are doomed never to see their potential realized? Or are there ways around the difficulties?

I think that in many instances the difficulties do win out. Acoustic systems with real musical possibility have been, and will continue to be, overlooked because no one happens to have the imagination to recognize the potential, or the commitment to follow it through. This is sure to be most true of sound sources which are not closely analogous to well-known types.

Yet examples exist of new instruments which fulfill their purpose -- they get played, they get heard, people enjoy them; music happens and at least some of the instruments' personalities are able to come forth. There are several possible reasons why these instruments have better luck than those that remain unexploited.

Some instruments simply produce a sound that is so beautiful that no one could fail to respond. And some produce the sound without demanding a highly developed technique, making it widely accessible. The example that springs immediately to mind here is Richard Waters' Waterphone. I mean, what can I say? -- it produces an absolutely ravishing sound. Only a zombie could ignore it.

And someone picking up the instrument for the first time can easily make it sing, so willing is the instrument to let its voice be heard. In fact, when Waters plays the instruments -- and he has probably played them more than anyone else -- the things he does are not so very different from what a beginner can do. The result of all this is that the Waterphone is one of the most successful and most widely heard of the new acoustic instruments, despite its being radically different from any conventional instrument. (An article on the Waterphone is scheduled to appear in the next issue of EMI.)

There is a lot to be said for this sort of anti-virtuosic thinking in new instrument design. By making instruments as friendly as possible, with playing technique simple and accessible to anyone, the builder can reduce the barriers that stand between the novice to the instrument and the instrument's musical personality. This agrees nicely with the often-expressed suggestion that it is important to lessen the walls that exist between people who consider themselves musicians and those who do not, and in doing so make it more possible for nominal non-musicians to become actively musical. All of this may be part of the reason that many of the new instruments now appearing are percussion instruments. True it is that the percussion section is a very demanding little corner of the musical world, but the obstacles to initial entry are small: anyone can gather together a sampling of resonant objects and hold a stick to strike them.

A second reason for the popular success of some new instruments, relevant to those with more demanding technique, can be the appearance of one or two virtuosos. Some convincing performances on a new instrument can help make its potential clear for all to see -- although experience has shown that a healthy dose of stick-to-it-iveness is always necessary before people will respond in large numbers. Allen Albright has demonstrated his wooden double ocarinas at crafts fairs and the like with an astonishing degree of virtuosity, as if to say "Here is something new and very special, and just listen to what it can do!" On a larger scale the same is happening with Emmet Chapman's Stick, an electric guitar-style instrument designed for a demanding two-hand hammer-on technique rather than plucking of the strings. Inspired by a few highly-skilled players giving demonstrations, a number of people are now studying the instrument seriously. It may well be on its way to a stable position and general acceptance (perhaps aided, inadvertently, by the sudden stardom of guitarist Stanley Jordon with his similar technique on conventional electric guitar).

And if by chance the existence of one skilled performer does not lead to an instrument's widespread acceptance, this need not be considered a tragedy. It at least means that the instrument has been given a chance to sing its song -- something that could never be regarded as futile.

Another possible reason for the popular success of some new instruments may be some attractive attribute unrelated to the instrument's sound or playability. The physical beauty of an instrument can most certainly draw people to it, and make them more willing to take the time to explore its possibilities. This has been apparent in the response to Nazim Ozel's Semi-Civilized Tree. An intriguing but easily-grasped concept will also win some friends -- witness people's peculiar fascination with some of the long-string installations appearing recently. And, of course, an appealing, funny or outrageous name for the instrument will at least turn a few heads.

Another means of ensuring that the potential of a new instrument will not remain concealed behind the wall of its unfamiliarity is to plug it into an existing tradition. One way to do that is to give it a keyboard. Now, some acoustic designs are more amenable to keyboards than others. But purely electronic instruments can be made to fit virtually any configuration, and keyboards have been adopted almost universally for them. (Although it is interesting to note the appearance of other imitative configurations for controlling synthesizers, such as the increasingly popular guitar synths.) Clearly the universal keyboard has been a very practical policy, but it is also a mixed blessing. It has the disadvantage that it encourages people to slip into familiar styles of music, patterns of notes, and tuning systems. By contrast, a new acoustic sounding system with a playing action which arises organically from its own mechanics will surely produce music that is truer to the individual personality of the instrument, and fresher to the ear.

One more approach the the question of how new instruments can find their place in the world occurs to me, and I think it is an important one. There is an almost universal tendency for people to think about musical instruments in terms of existing types. One sees an instrument, and one naturally categorizes it as a balalaika, a viola d'amour, a hardanger fiddle, or whatever is appropriate. With established types, the assumption is that many nearly-identical instruments of the type can be found, existing in conjunction with a corps of trained players and established styles and repertoires. This historical and cultural state of affairs predisposes us to measure the success of any new instrument along similar lines: will it catch on, will it be produced in quantity, will many people play it, hear it and write for it? The topic of this article has been, in essence, problems following from that kind of thinking.

Well, why not simply discard that line of thought?

Why not take an attitude closer to that of a sound sculptor? One can produce pieces to explore various acoustic possibilities, without necessarily regarding each individual piece as representative of a type. A less repressive measure of success is then free to come to the fore. An instrument is filling its potential if it produces an interesting, enjoyable or musical sound. The individual instrument exists; the maker, if no one else, will bring the music out of it, and its music will be that much more precious for the fact that it will not be created elsewhere by identical instruments of the same line.

RECENT ARTICLES APPEARING IN OTHER PERIODICALS

Listed below are selected articles of potential interest to readers of **Experimental Musical Instruments** which have appeared recently in other publications.

NEW WAVE ORGAN, by Gray Brechin, in **San Francisco Focus** Vol. 33, #6, June 1986 (680 8th St., San Francisco, CA 94103).

An article on the Wave Organ currently being built on the waterfront in San Francisco's Marina. The wave organ, designed and built by Peter Richards (currently artist-in-residence at SF's Exploratorium) aided by stone masons George Gonzales and Tomas Lipps, is a series of pipes up to 15 ft. long, set in the stone at the water's edge, sounded by the motion of waves and tide.

SONIC DISCOVERIES OF A SCULPTOR-PERFORMER, by Ward Hartenstein, in **Percussive Notes** Vol. 24 #4, April 1986 (214 W. Main St., Box 697, Urbana, IL 61801-0697).

Ward Hartenstein makes exquisite instruments of ceramic and natural materials. In this article, appearing in Jon Scoville's regular "Instrument Innovations" feature, he describes his work and some of the thinking behind it. Includes several fine photographs. These pieces are very much worth seeing, both for their extraordinary beauty and for the musical and acoustic feeling behind them.

Also in the April issue of **Percussive Notes** (address above): Several features on STEEL DRUMS, including history, future possibilities, performance, arranging, and education.

(continued on page 9)

A JUSTLY-TUNED GUITAR, by David Canright, in **1/1** (Just Intonation Network, 535 Stevenson St., San Francisco, CA 94103).

A description of a guitar which the author refretted for just intonation, and of the thinking behind it.

Several articles of interest appear in the current **Journal of the Catgut Acoustical Society,** #45, May 1986 (112 Essex Ave., Montclair, NJ 07042):

OVERWRAPPED STRINGS: DESIGN GUIDE INCORPORATING ACOUSTICAL LIMITATIONS, by Ian Firth, provides mathematics useful in the design of strings applicable to both plucked and bowed instruments.

MEASUREMENT OF SOUND QUALITY OF WOOD FROM QUEBEC FOR CONSTRUCTION OF MUSICAL INSTRUMENTS, by Francis W. Slingerland, analyzes acoustic properties in samples of fir, spruce and maple from Quebec for the purpose of comparison to imported woods. (The article is in French, except for a summary in English.)

ON MEASURING WOOD PROPERTIES, PART 3, by M.E. McIntyre and J. Wodehouse, discusses the elastic and damping constants of woods, particularly spruce and maple, and some approaches to assessing them.

This issue of **Journal of the Catgut Acoustical Society** also has a number of items on the ongoing development of the Violin Octet, the family of scientifically-designed bowed strings which members of the society have been creating.

TREATING WOOD TO DISCOURAGE CRACKING, by George Jameson, in **Techni-Com** Vol. 8 #5, Oct.-Nov. 1984 (National Association of Band Instrument Repair Technicians, Box 51, Normal, IL 61761).

Description of a method for sealing woodwind woods.

Untitled, on page 8 of **Techni-Com** Vol. 8 #2 (address above).

Description of two modified trumpets designed by Pat Vidas. One has attached pitch wheels and oscillator frequency controls to allow the trumpet to control a synthesizer. The other has a flame throwing device built in to the instrument, so that the instrument literally spouts flame from the bell.